

## 5 SUMMARY

There is a clear need today for a CEBAF-class facility operating at 12 GeV. Such an upgrade will make profound contributions to the study of strongly interacting (*i.e.*, nuclear) matter. It will open up qualitatively new and vital research capabilities on:

- the origin and nature of quark confinement by discovering the flux tubes responsible for quark confinement in the form of the gluonic excitations of  $q\bar{q}$  systems, and
- the quark-gluon structure of the nuclear building blocks by mapping out for the first time quark momentum distributions in the valence quark region and by opening the door to mapping out the quark-gluon *wavefunctions* of the nucleons by exploiting the rigorous methods opened up by the newly discovered Generalized Parton Distributions.

It will also open up major new research capabilities on:

- the transition from the hadronic approximation to strongly interacting matter to the fundamental quark-gluon description through the study of quark-hadron duality in the region of the onset of deep inelastic scaling;
- delineating the forces between quarks by examining the high-momentum components of the quark-gluon wavefunctions of hadrons through measurements of the high- $Q^2$  behavior of their elastic and transition form factors;
- using the threshold  $\psi N$  interaction as a probe of color van der Waals forces that are expected to play an important role in the  $NN$  interaction;
- using deep inelastic scattering to map out the short-range correlations in nuclei;
- learning about the basic nature of hadronic interactions by searching for the phenomenon of “color transparency”;
- examining the dependence of hadron structure on the quark mass by exploiting the  $s\bar{s}$  spectrum as a bridge between heavy quarkonia and heavy-light systems, which are both well understood, and the complex light quark world; and

- providing important new data on the form factors and couplings of the Goldstone bosons of QCD, including the  $\eta'$ .

Jefferson Lab can realize the required accelerator upgrade cost-effectively by building on the remarkable performance of CEBAF's superconducting radio-frequency cavities, on free space in the linacs made available when it became possible to build a five-pass machine, and on a physical layout that was designed to accommodate a much higher energy than CEBAF's 4 GeV design energy. The existing experimental equipment can also be readily upgraded to accomplish the physics objectives that drive the Upgrade. Moreover, the required Hall D equipment is remarkably economical because its major components are already in hand.